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ABSTRACT

This report describes the activities and recommendations of the Chancellor's Energy Task Force, which was established to give emphasis and direction to systemwide energy education efforts within the Hawaii community colleges. Part I describes the activities of the Energy Conservation on Campus Committee, which resulted in campuswide plans to identify conservation needs, assess conservation efforts, recommend incentives, and determine possible areas for future conservation. Part II contains a local manpower and feasibility study report. After identifying alternative energy sources (i.e., bioconversion, geothermal, ocean thermal, direct solar energy, and wind energy) and describing study methodology, the study report considers findings in the areas of industry growth plans and potential, industry's labor needs over a five-year period, and requisite employee skills. The Energy Education Committee's recommendations, based on study findings, are then presented, including the recommendation that no programs be initiated at this time, though courses focusing on alternative energy sources be added to existing curricula. Part III summarizes the activities and recommendations of the Energy Awareness for Campus and Community Committee, noting survey results on energy-related instruction on campus and recommending curricular modifications. Limited community services involvement by the campuses is noted and a leadership role in community education recommended. (KL)

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INTERRELIANCE

AN ENERGY AWARENESS PROJECT FOR THE COMMUNITY COLLEGES

A Report of the Task Force on Energy Education

University of Hawaii
Office of the Chancellor for Community Colleges

March 1982

JC 820 128

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Background of the Project

During an era of abundant, cheap energy, America produced a stock of capital goods and lifestyles that require enormous amounts of energy. Now, as the country enters an era of scarce and costly energy supplies, it is necessary to adjust to pervasive social, economic, political, and environmental changes. Transitional pains can be eased through a combination of understanding, preparation, and enlightened decision-making regarding personal consumption and political issues. Traditionally, our society has relied upon the educational system to equip people with the knowledge, skills, and attitudes needed to participate in society as informed and active citizens, workers, and consumers. As societal conditions, policies, and goals change, we expect commensurate changes in the educational process. If, as individuals and as a nation, we are to meet the multifaceted challenge which the energy crisis presents, it is imperative that energy be considered a basic educational theme throughout the school curriculum in all relevant disciplines. Not only must energy concerns permeate the formal school system, they must also permeate the non-formal (out-of-school) system, as the problems are too serious, too pervasive, and too imminent to be ignored.

Facing these enormous challenges, what can a community college system do? To avoid fragmentation, premature programming, and duplication of efforts, it seems crucial to link the varied areas of concern together. Energy, environment and education are interrelated in fundamental ways that suggest a structure for a system-wide plan.

First, Hawaii's university system for example, is the State's major consumer of electrical energy. Like the rest of society, it must learn to cut back on consumption by developing methods to conserve energy, retrofit existing facilities and design new facilities that will operate more energy efficiently. A notable consequence of these measures will be to redirect tax dollars from energy consumption to the delivery of education.

Second, community colleges are not in the research business, but have the mission of providing individuals with the technical training to lead us toward an energy efficient society. New technicians and professionals may have to be trained or present workers, retrained in emerging energy, pollution and environmental technologies. With the occupational focus already in the community colleges, we have the skills to translate that potential into a reality.

Third, and perhaps most important, educational institutions must focus on the realities of the 21st century and develop the perspectives and attitudes that will assure global survival in the future. The energy crisis requires not only new technology, but new values as well. Energy awareness must become an integral part of our classroom teaching and community service projects. We can avoid fragmentation by making "energy education" permeate all of our activities, rather than creating another fragment.

Each of these tasks—conservation, technical training, and value change—represents a major challenge to our community college system. With these goals in mind, the Chancellor's Energy Task Force was formed and began work in three groups, 1) Energy Conservation on Campus; 2) Energy Education Technician Programs; and 3) Energy Awareness Education for Campus and Community. Each group set its objectives and worked toward making recommendations that would give emphasis and direction to a systemwide effort.

PART I

Energy Conservation on Campus

This committee of the Task Force was staffed by the campus administrative officers and a representative from the Chancellor's Office. During the period of work, a simultaneous University-wide thrust was made in this area, with requirements and guidelines set by the President's Office. Since the goals set by the committee were similar to those set by the University System for energy audits and conservation plans, the individual administrative officers met as a group to discuss problems and conservation alternatives but primarily worked with campus administration to comply with the system requirements.

Recommendations

Each campus now has, or is in the final process of completing a plan which, 1) identifies areas requiring energy conservation; 2) assesses the effectiveness of conservation measures now in action; 3) recommends incentives for conservation; and 4) identifies possible areas for future conservation such as retrofitting electrical systems, alternative use of facilities, including those that may require different schedules of classes, or fewer hours of evening and weekend use of facilities.

PART II

Energy Education: Programs in Alternative Energy Technology

The second committee of the Task Force identified several major issues that need to be addressed before any recommendations could be made regrading the initiation of new energy technician certificate or degree programs in community colleges in Hawaii. Several national studies, including the 1981 Report on the National Center for Research in Vocational Education, Energy: Factors Influencing Vocational Education Policy, emphasize that, as yet, vocational educators do not have adequate data on energy job markets or projections upon which to base educational policy decisions.

Vocational education leaders have generally expressed fear of training people for non-existent jobs. In fact Doggette and Stevenson (1980) describe problems caused by responding too early to calls for specialized training for environmental technicians. Although experts projected great demands for graduates, the environmental technician never materialized as an occupation. They emphasized that "vocational education planners must be wary of projected long-term job markets which cannot be supported by local and regional job analysis" (p. 52).

In the area of solar energy, for example, a field generally discussed as a natural for Hawaii, Forgionne and Kopp (1979) and Bartlett (1980), the energy-related job projections have been

speculative and over optimistic. "In solar energy," they report, "employment statistics vary widely, but there is general agreement that the industy will influence existing occupations to a greater degree than it will create new occupations."

Albright (1980) indicated that 96 percent of the skills required in the active solar field are those already taught in traditional heating, air-conditioning and ventilating, plumbing and metal work curricula.

Given these national trends, the committee recommended that at this stage, a proposal would be developed to use a research associate to complete a local manpower and feasiblity study for possible energy technician programs in Hawaii. The completed report follows. The conclusions and recommendations confirm those in the national studies.

Energy Education Technician Programs: A Feasibility Study

The purpose of this study was to examine whether or not Hawaii's Community Colleges should develop and, subsequently, offer a program geared to train alternative energy source technicians. Because Hawaii has almost complete dependence on imported energy generating fuel and because this places the economic and social survival of the state at the mercy of external forces which are beyond its control, alternative energy sources have become an important issue in our island State. While considerable attention has been focused on the research and development of alternative energy sources and also on the conservation and uses of energy, there has not been much attention directed to the workers required by the energy occupational field. Because of this,

there has been a lack of any systematic inquiry into the types and levels of technical skills and knowledge required of workers who may work in the energy industry. While these discrepancies may or may not affect the technical and manpower development in the state, the implications for the community colleges, at this point in time, are clear: They should have a clear idea of the direction in which they should be heading in meeting training needs in the state.

Alternative Energy Source Background

Review of selected literature provided information of the various types of alternative energy sources. Technical reports provided insights as to how the various systems functioned and as to the applicability of the alternate energy systems in Hawaii. Bioconversion, geothermal, ocean thermal energy conversion, direct solar, and wind were the five major alternate energy fields that appeared to have the greatest potential.

Bioconversion

This technology essentially releases, or converts to another form of energy, the solar energy stored in plant and animal material.

There are three basic types of bioconversions:

Burning The biomass is fed into a boiler and burned. The resultant heat causes water to vaporize and this steam turns a turbine which is connected to a generator. The generator produces electricity, a useful form of energy. Some biomass materials used are bagasse (the fibrous remains of the sugar

cane stalks after the sugar juices have been removed), wood chips (Eucalyptus, Giant Koa Haole), municipal wastes, etc. Of the three types of bioconversion, burning is the most developed and used form of conversion.

Liquid Fuels Biomass material is usually fermented to produce liquid hydrocarbons (ethyl or methyl alcohol). This liquid hydrocarbon could be used as an automobile fuel such as gasohol (10% alcohol to 90% gasoline) or directly with a few engine modifications. Pyrolysis (burning at high temperatures with the absence of oxygen) of biomass can also produce liquid fuels. Depending on composition and operating conditions, municipal refuse yields char, tar, pitch, light oils, organic acid and alcohols, and gases. These products can be separated and used as a fuel. There are pyrolysis plants in the U.S. but there are no immediate plans for the construction of such a plant in Hawaii.

Another biomass application of interest is the production of liquid fuels from algae. At a projected production rate of one barrel of petroleum equivalent per acre per day, it is estimated that a crew of 70 people could operate a 1000 acre algae producing 1000 barrels of liquid fuel per day. The conversion of algae to liquid fuel is largely in the research and development stage. The commercialization of this energy conversion appears to be slight.

Gaseous Fuels Various biomass materials may be converted to a gaseous fuel, such as methane, by an anaerobic digestion treatment process. The biomass material is broken down by bacteria that is carefully introduced to maximize the production of gases. Some biomass materials that have been used in this process has been seaweed, cow manure, plant material, and in theory any organic substance could be used.

Various feasibility studies have been conducted to produce methane by this method, but it is not expected that it will develop into a large job market within the near future. Some small plants may be in operation, basically on farms where large amounts of manure is available.

Geothermal

Geothermal energy is basically energy derived from below the earth's surface. While there are six major types of geothermal wells that can be utilized for energy purposes, only three are discussed here. They are: dry steam, wet steam/hot water (low temperature fields) and hot rocks.

Dry Steam Though dry steam wells are rare, they are perhaps the simplest to utilize for electrical purposes. These are the type of wells that are used at the Geysers in California to produce electricity. Steam which is being produced in the sub surface wells is transported to a generating station through a main steam line. Along with the steam comes a large amount of dust. Centrifugal separators, Y-strainers and double valves are all utilized to rid the system of the

dust. From the steam separator the steam is passed through a turbine to produce electricity. The steam is then cooled and condensed before it is re-injected into the ground to be used again.

Wet Steam and Hot Water Wet steam wells become a bit more difficult to use for they will often produce three times as much hot water as they do steam. An additional step must therefore be taken to turn this hot water into steam. This is done by a process called "flashing" (Tester and Milora, 1976). In this process the hot water is introduced to a low pressure region. This causes the water to turn to steam. If the temperature is not hot enough to flash water to steam, "working fluids" can be used. These working or secondary fluids are heated by the hot water from the wells. As fluids are heated they expand, increasing their pressure which in turn run a turbine.

Hot Rock Hot rock geothermal wells constitute the majority of geothermal resources in the world (Cheremisinoff and Morresi, 1976). However, they are the hardest to utilize for electrical purposes because, in this process, water must be injected into other region of high temperature concentration. The difficulty is in the creation of some type of underground reservoir or fracture system to circulate the water through. The now hot water is brought back up and used to generate electricity in much the same way as is done for a wet steam or hot water well.

Ocean Thermal Energy Conversion

The basic concept in Ocean Thermal Energy Conversion (OTEC) is to utilize the temperature differential between warm surface and cold deep-ocean waters to produce electrical power.

There are four main types of OTEC plant configurations.

Moored Platforms The moored OTEC platforms are floating structures attached to the sea bed by mooring lines. There are various design possibilities for the hull depending on the circumstances of a given location. The hull could be either rectangular, cylindrical, spherical or disk shaped. It could be surface floating, semi floating or submerged.

Bottom-Resting Tower The Bottom-Resting Tower is a stationary platform designed for water depths of less than 300 meters. The cold-water intake pipe would extend down from the platform to the sea-bed and along the Continental Slope to the appropriate depth.

Land-Based Platforms Land-Based Platforms could also be used if they are constructed at sea-level with their intake and discharge running through pipes below the ground.

Plant Ships Plant ships would be much smaller than the moored plate forms and would probably produce energy-intensive products such as ammonia and alumimun. OTEC I is of the plant ship design and will be used to conduct experiments to determine the feasibility of larger OTEC plants.

According to an Impact Statement released by NOAA (1981), there are five methods by which OTEC plants can generate energy.

Closed-Cycle System At present, hardware for this system is closer to commercial availability than for any other type of system (DOE, 1980). In the closed-cycle system, warm surface water is pumped through a heat exchanger where it is used to vaporize a working fluid with a very low boiling point. Once the working fluid has been transformed into a vapor it is passed through a turbine to produce electricity. The working fluid is then passed through another heat exchanger where it is condensed using cold seawater. The cycle is then repeated.

Open-Cycle System The open-cycle system uses seawater as the working fluid. The warm seawater is directed into an evaporator where the lowered pressure changes the water to steam. This process is called flashing. The steam is used to drive a turbine and is then condensed by the cold seawater.

Hybrid System In this system the warm seawater is flash-vaporized and then used to evporate a working fluid which runs through a closed-cycle system.

Mist-Flow System This method is very similar in concept to a water fall. Warm surface water is taken in at the top of the plant and allowed to drop over turbines. This "waterfall" will turn the turbine to produce electricity. From there the warm water is flashed-vaporized and floats back up to the surface level of the OTEC station. Once there, the vapor is condensed with cold seawater and then discharged.

Foam System This process is similar to the mist-flow system. Warm seawater is mixed with a substance that causes foam to be produced. When the water is vaporized in a low pressure chamber large amounts of foam will form. This foam is drawn to the top of the chamber where it is condensed and allowed to fall through pipes over turbines. The water is then discharged.

Direct Solar Energy

Energy derived directly from the sun's rays is at present the most marketable of the alternative energy sources. There are three main categories of solar energy which are being used today.

Passive Solar Heating In passive solar heating, buildings are designed in such a way to best utilize direct heating from the sun. Heat energy is transferred into and out of a building basically by natural processes such as conduction, convection and radiation (DOE, 1980). The building design must therefore concern itself with the location of windows, walls and insulation and other features of the building.

Active Solar Heating Under this heading there are several methods but all involve the sun heating a liquid.

Direct Solar Space and Water Heating Direct solar space and water heating systems are capable of heating buildings as well as water. Solar energy is used to heat a liquid which can be circulated through a building to heat its interior. These systems usually provide for storing the heated fluid for use at night (DOE, 1980).

Absorption Cooling Cycle Absorption cooling cycle systems are used mainly for cooling buildings. Here solar energy is used to boil a refrigerant (a liquid with a low boiling point) out of water. The refrigerant is condensed back to a liquid in a condenser. This refrigerant is allowed to circulate through room air absorbing heat as it does. This process cools the room air and boils the refrigerant which is cooled with water before the cycle is repeated. (Cheremisinoff and Regino, 1978)

Thermoelectric Conversion Active solar heating can also be used to produce electricity through processes called thermoelectric conversion. The basic idea is that solar collectors supply heat to vaporize a working fluid which, as it expands, can turn a generator. Though the methods for doing this are many, central receiver solar thermal power plants have been given much consideration. There

are three major components to these plants. One is a field of movable mirrors called heliostats. These mirrors reflect the sun's radiation to the central receiver which is the second component. The third component is a tower upon which the receiver is mounted. These plants are capable of producing 300 MWe.

Photovoltaics This is the process by which the sun's radiation is turned directly into electricity by using solar cells. Solar cells are usually composed of silicon with traces of phosphorus and boron to offset the balance of electrons in the silicon. As the sun strikes the surface of the cell, energy is delivered to the boron-silicon layer (p-layer). This frees electrons from the silicon atoms leaving "holes" in the electron structure. These "holes" are filled by free electrons. It is the flow of electrons to "holes" that produces an electric current. Metal contacts in the cells collect this electric current and transport it off to do some type of work.

Wind Energy

Deriving energy from the wind is an old process with new interest. Though windmills have served many purposes in the past, renewed interest has taken place in their ability to produce electricity. Windmills or as they are more properly called "wind energy conversion systems" (WECS) fall mainly under one of two categories.

Horizontal-Axis Machine Horizontal-axis machines are windmills with varying shapes but with their rotating axis parallel to the flow of the wind. No matter what the shape, the basic principle is the same. As the wind blows across the face of the windmill the blade or blades begin to turn. As they rotate, they drive a turbine which produces electricity.

Vertical-Axis Machine Vertical-axis machines are a more recent development beginning basically in 1929 with the Savonius rotor. These vertical-axis machines have their rotating axis perpendicular to the direction of the wind. The major advantage of this design is to enable the windmill to utilize wind coming from any direction. The windmill does not have to be facing into the wind as does a horizontal machine. The principle for producing electricity is the same however.

Summary

While these various alternative energy systems provide encouraging promises for the State, the actual movement towards commercial applications are still in various stages of development, i.e., the direct solar energy system has been extensively applied for hot water heating, while OTEC is still being researched and developed. Irregardless of the stages, the further development and commercial application of alternative sources of energy are imperative if the state is to remain economically stable. The required impetus to

accelerate development will be directly related to the relative cost and availability of imported oil. As the cost increases and supply dwindles, the development of alternative energy sources will accelerate. Concurrently, there should be need for workers with new skills and knowledge to make one or several of these alternative energy systems commercially viable. The types and kinds of skills and knowledge required of workers would depend on the development of technology in applying these alternative sources of energy.

Methodology

As the review of selected literature provided information concerned with alternative energy systems that hold promises for Hawaii, the study focused on the collection of data and information of those systems that are in various operable stages, but not necessarily commercially applied in the State. This was accomplished by identifying industrial/business firms that would be in the development and/or application of the alternative energy systems and by interviewing key people in the firms. These firms were identified by going through the yellow pages of the telephone directory. Also, additional interviews were conducted with individuals who were known to be involved in alternative energy research at the University of Hawaii at Manoa and at several energy related state agencies.

Thirty firms directly related to the solar field were identified. However, some of these had moved, addresses were unknown or had gone out of business. Of the number remaining, ten firms were selected

based on their size and volume of business. Small firms were deleted because they would not significantly impact the job market for workers with specialized skills and knowledge. Persons interviewed were generally heads of the firm or its personnel director.

Gathering of information and data of other alternative energy systems were also through interviews. However, because they were less commercially developed and not listed in the yellow pages, they were difficult to identify and locate. Identification of interviews were through the personnel at Hawaii Natural Energy Institute (HNEI) and their referrals. Consequently, the interviews were with individuals involved in the research, design, planning and development of specific alternative energy systems.

The interviews were held during the months of May through July, 1981. They were open-ended but focused on obtaining data and information that would contribute to the attainment of the objectives of this study.

Objectives

The objectives of the study were:

1. Determine an estimate of the number of workers needed to maintain the alternative energy systems.
2. Determine an estimate of the manpower need of the alternative energy systems industry for the next five years.
3. Determine the skills and knowledge required of workers in the alternative energy systems.

Collection of Data and Information

Responses from the interviewers were recorded on forms specifically developed for this study. (See Appendix A.) Whenever possible, the interviews were in person and lasted for approximately 30 minutes. Few of the individuals, however, were too busy to schedule personal interviews but were willing to be interviewed over the phone. These telephone interviews lasted approximately 10 minutes. This was adequate to ask key questions.

The specific alternative energy source system data and information were compiled and analyzed. Statistical tools were not used to analyze the data because of the limited sample and lack of controls. As such, the findings and conclusions are cautiously interpreted and meant to convey general findings and trends.

Findings and Discussions

The data and information are grouped according to the alternative energy source systems. For each system the data and information are linked to the objectives of the study and a short discussion ensues.

Bioconversion

The bioconversion system of alternate energy is not new to the state. It has been in operation for a number of years. However, newer application of this source show definite promises.

Bagasse - Burning The sugar plantations throughout the state have burned bagasse for a number of year to produce the second largest source of energy in Hawaii. Presently, bagasse provides close to 8

percent of the state's energy needs. On some islands, like Oahu, bagasse doesn't make a significant contribution to the island's need, but on the Island of Hawaii, energy generated by bagasse burning accounts for approximately 35 percent of the electricity distributed by Hawaii Electric Light Company (HELCO). Moreover, many sugar plantations are improving their electrical production capacities. These will reduce their dependence on high cost bunker fuels, and they will be selling their excess electricity to the utility companies.

A notable advancement in the use of bagasse is Davies' Hamakua Sugar Factory converting raw bagasse to "Woodex" pellets. Bagasse is usually high in moisture, perishable and difficult to transport. The pellets are compact, dry, compressed, and portable. For a given volume the pellets are rated to yield about 10 times the energy of loose bagasse. Bagasse driers use waste boiler heat, thus, increasing the energy content per volume. Where bagasse is limited in supply plantations are burning or planning to burn wood chips so they can extend their ability to produce electricity for utility companies.

While bagasse and wood chip burning provides alternative source of energy, there has been very little in the area of job creation. The sugar plantations in keeping their costs down have used automation to a great extent. The Davies' Hamakua Sugar Factory has designed, built, and maintained its new power plant that utilizes "Woodex" pellets with company employees; as a result, basically no new jobs were created. The Lihue Plantation Company's new power plant requires only three workers at a time to run the plant. There are 15 workers in all. Of the 15, 12 were Lihue Plantation employees and the remaining 3 were new hires.

Consequently, even though the sugar plantations are producing more electrical power, new jobs have not really been created. If jobs were created, they would be first filled with company personnel before new hires are brought in. Jobs are classified into feed operators, monitors, mechanics, and electricians. Mechanics and electricians require supplemental training in the area of power generation. Presently, there are two ways in which power generation can be learned. First, through formal classroom training and, second, through on-the-job training. HECO has an apprenticeship training program designed for its equipment. The operators and monitors essentially learn on-the-job without any formal classroom pre-service training.

Wood - Burning Wood has long been a fuel for man, but with the discovery of fossil fuel the use of wood has dwindled significantly. Now with the renewed emphasis on renewable alternate energy resources, wood again is starting to take an important role in power generation. The potential for use of wood as fuel in Hawaii is untapped. Hawaii has about one million acres of potential commercial forest land. The largest blocks of these lands (65%) are located on the Island of Hawaii. Promising sites with commercial potential are along the Hilo Coast and in the Ka'u area southwest of Hawaii Volcanoes National Park.

To tap this potential energy source, BioEnergy Development Corporation, a C. Brewer subsidiary, along with both Federal and State help, started a tree plantation in 1979. This pilot plantation will help to determine the types of Eucalyptus trees that grow best in different locations. One hundred acres have been planted and 200

acres will be added annually until 900 acres are planted. However, the 900 acre goal will depend on Federal funding. As of July 1981, 526 acres were planted. The Eucalyptus tree reach harvestable size (50-60 ft.) after five to seven years. BioEnergy expects that they will start harvesting sometime in 1984. An annual per-acre yield of at least 20 tons greenweight of wood fiber is a prime objective. The harvested wood would then be chipped and sold to sugar plantation power plants. The wood chip would be a fuel supplement to the bagasse that are already being burnt.

BioEnergy currently employs 20 people. Thirteen are hourly paid: 2 nursery men, 6 planter/fertilizers, 5 field maintenance. Each group has a lead worker who directs the rest as to what needs to be done for the day. These 13 people are basically laborers and need no special training. The 7 others are salaried workers: 2 part-time secretaries, 4 research personnel, and a manager. There are no plans to increase the working force and, depending on the availability of federal funds, the working force may be reduced.

If the BioEnergy project is successful, there are possibilities of seeing more tree plantations on the Island of Hawaii. Plans are being drawn for a tree plantation on Molokai growing Giant Koa Haole trees. These ventures will create a variety of new jobs but, unfortunately, most of the jobs do not require specialized skills. Some forestry knowledge would be helpful but not essential. In addition, power plants just burning wood chips could be envisioned, but like the sugar plantation power plants the number of jobs will not be significant.

Municipal Waste - Burning In any large city, huge amounts of refuse is created every day and with it the problems of disposal. On Oahu it is estimated that refuse disposal at its present rate will exhaust all the landfill sites in 15 years. Thus, another form of disposal will be needed in the near future.

A method of disposal is to incinerate the waste. If the heat produced were used to generate electricity, the urban wastes could contribute up to 10 percent of the electric power requirements for an urban area from which waste are collected. (Mainland cities which burn coal can mix combustible wastes in the ratio of five to one in burning, but Hawaii's steam power plants have not been designed for burning coal.) Unfortunately, steam generating plants designed especially for burning urban wastes are said to cost 10 times as much as conventional plants burning fossil fuels.

The Honolulu Program of Waste Energy Recovery (HPOWER) is a Honolulu City & County plan to take tentatively 1800 tons of trash a day, sort it, dry it, shred it, then burn it to heat water to produce steam to turn turbine to create electricity. The electricity will then be sold to the electric company.

HPOWER would create a number of jobs during the construction phase; however, the construction will be done by a contractor that has its own work force. Also, it is projected that the maintenance of HPOWER once it is constructed will create approximately 77 new jobs. These jobs will require a wide range of technical skills and educational background. However, they generally do not require newer type of training, i.e., the existing training programs will be adequate. Table I displays the job titles, number of workers, skill levels and educational requirements for HPOWER.

TABLE 1
Job Titles, Number of Workers,
Skill Levels, and Educational Requirements
for
Jobs Created by Installation of HPOWER

Job Titles	Number of Workers	Skill Level	Educational Requirement
Plant Manager	1	Registered Engineer	College-work experience
Plant Engineer	1	Engineer	College
Shift Engineer	5	Not available	Poss. college education
Clerical	2	Secretarial	Comm. or Bus. College
Weighmaster	4	Not available	On-the-job
Spotter	2	No skill	On-the-job
Equipment Operator	6	Heavy Equip. License	On-the-job
Machine Oper/Mech	2	Mechanical skills	Comm. or Tech Coll, On-the-job
Machine Operator	4	Not available	On-the-job
Control Room Operator	2	No skill	On-the-job
Landfill Jobs	7	Heavy Equip. License	On-the-job
STEAM PLANT JOBS			
Chief Operator*	5	Mechanical	Power generation knowledge
Asst. Operator*	5	Not available	On-the-job
Fuel Feed Operator*	8	Not available	On-the-job
Aux. Operator*	5	Not available	On-the-job
MAINTENANCE SHOP			
Shop Supervisor	1	Journeyworker**	CC or work experience
Instrument/Electrical	1	Journeyworker**	CC or work experience
Electrician	1	Journeyworker**	CC or work experience
Automotive Mech.	2	Journeyworker**	CC or work experience
Welder/Fabricator	3	Journeyworker**	CC or work experience
Mach. Oper/Mech	1	Journeyworker**	CC or work experience
Mach. Oper/R&M	2	Journeyworker**	CC or work experience
Powerhouse Leadman	1	Journeyworker**	CC or work experience
General Labor	6	No skill	On-the-job

*Not sure about requirements.
**Maybe not a full fledge Journeyworker but near it, Work experience important.

It is really not known when and where HPOWER will be constructed. The original proposal had HPOWER being built near the Oahu Sugar Company, Ltd. at Waipahu, but due to community opposition the fate of HPOWER is unknown. Some arguments given were: negative air quality,

increase noise, increase traffic (300 round trips of garbage trucks), rodents and insects, fear of land devaluement, and nobody really wants a refuse incinerator in "their" backyard. The C&C of Honolulu is now looking at alternative sites for the plant. One alternative would be at Campbell Industrial Park. Hopefully, HPOWER will be built by 1985.

If HPOWER fails to be built some other alternate plans are:

1. Waste Treatment Plant Modifications. The Sand Island sewage plant will burn sewage and refuse to heat boilers. This plant may be built even if HPOWER goes through, since it is an innovative idea. Federal funding will determine its fate. If constructed, approximately 58 workers will be needed to operate and maintain the plant.
2. Retrofitting the Waipahu incinerators. Power generation equipment will be installed to make use of the current waste heat. The project could be completed by 1985 and approximately 13 additional workers will be needed.

Alcohol - Liquid Fuels There are presently on the Island of Oahu, two separate commercial facilities that produce alcohol via the anaerobic fermentation process. These include the facilities at the Del Monte Pineapple Cannery, and the Honolulu Sake Brewery and Ice Company. The alcohol produced is used mainly for consumption. Del Monte ships the alcohol produced to the mainland to be converted to vinegar. While the expansion plans of these firms are unknown, there have been develpments involving other Hawaii based firms in producing alcohol.

C. Brewer & Co., Ltd. has plans for an ethanol plant on the Island of Hawaii. When constructed, the plant will require approximately 37 people to maintain and operate the plant. Detailed number of workers in specific job titles is unknown but the general job titles and desired educational backgrounds have been identified. The requirements fall into a wide range of educational requisites but generally can be obtained with existing educational programs as shown in Table 2 below.

TABLE 2
Job Titles and Educational Requirements of Persons Employed in Alcohol Production Plant

Job Titles	Educational Requirement
Managers	College Degree
Plant Engineers	College Degree
Chemists	College Degree
Mechanics	Community College Degree and/or on-the-job training
Distillation Operators	Community College Degree and/or on-the-job training
Fermentation Operators	Community College Degree and/or on-the-job training
General Labor	On-the-job training

Pacific Resources, Inc., is currently conducting a one-year gasohol marketability test using wood alcohol imported from the Pacific Northwest. It plans to construct an alcohol production plant in the near guture in Hawaii. This plant should create approximately 25 jobs. The job titles and educational requirements should be identical with those reported for C. Brewer & Co., Ltd.

Hawaii's third and fourth largest industries, sugar and pineapple, could play significant roles in alcohol production. A major by-product in sugar production is molasses. The molasses could be fermented to produce alcohol. As previously noted, C. Brewer is

conducting feasibility studies on producing ethanol from molasses. Dole Company also is doing a feasibility study using pineapple waste (juice) to produce alcohol. While the potential for alcohol production is great, the manpower required for production will not change significantly.

Fermentation plants and distilleries are not labor intensive. There is strong likelihood that existing employees will fill the new jobs that are created. It is estimated that to produce 6 to 10 million gallons of ethanol per year, a work force of 15 or 16 people would be needed. These include two professionals requiring college background and the remainder would be skilled operators requiring on-the-job training.

Discussion

The principle of using biomass for generating energy has great potential of expansion in Hawaii. However, though there are and will continue to be a number of jobs directly related to this process, the skills and knowledge required can be learned in existing curricula at the technical and professional schools or on-the-job. Therefore, the need to develop and implement a specialized two-year program for workers in the bioconversion field appears unlikely.

Geothermal Energy

The concepts used in running a geothermal plant have been around for a long time. As such, geothermal plants do not create any new types of job for which formal educational programs is already not

available. Besides technological advances have automated the plant operations such as the plant presently in operation on the Island of Hawaii. It is highly automated requiring at most six people to operate and maintain the plant.

Hawaii's geothermal energy is entirely of volcanic origins. Hawaii Geothermal Project's A-well (HGP-A) utilizes the hottest reservoir in the U.S. to date and is classified as a hot water well. Therefore, it must utilize a flashing process to produce electricity. HGP-A began producing electricity on a commercial basis in May of 1981. At least three other wells are expected to be drilled over the next five years. Presently, Dillingham Corporation and the Geothermal Exploration and Development Company are doing exploratory work on the Big Island. Several wells are expected to be built on the Big Island to utilize the energy potential that is there. It is expected that a "full system" will be reached on the Big Island in about 10 years.

The energy produced by this "full system" of wells will be much more than the electrical demands for the Big Island. Therefore, laying a cable from the Big Island to Oahu is being considered. Direct applications of the energy are also being considered. The energy could be used in sugar processing, space heating or energy-intensive industries such as manganese nodule processing.

As this resource is developed further, jobs will be created requiring skills and knowledge in drilling, testing, designing and constructing, operating and maintaining and managing. In general, it is felt that these jobs can be filled with personnel in the already existing labor pool.

Discussion

With rapid advances in system designing and automation, job associated with operation of geothermal plants is below projections. In earlier research and development phases, it was estimated that in 10 years the number of people involved in geothermal could be up in the hundreds. However, judging from the current practice, most of the personnel required could be obtained from the already existing labor pool.

Ocean Thermal Energy Conversion (OTEC)

As of August 2, 1979, it has been proven that OTEC can produce energy. On this date Mini-OTEC became the world's first successful closed-cycle plant to produce net energy at sea. However, because budget cuts OTEC has not progressed much beyond this early breakthrough. Work continues but at a much lower level than would have been if more funding were available.

There is interest in sending Mini-OTEC back to sea. The objective this time will be to prove that energy can be transported from ship to shore via a cable or through the production of energy-intensive products, such as ammonia. In this regard, OTEC-1 a converted Navy tanker is scheduled for redeployment in 1983 to test various components, design and biofouling.

Though OTEC is promising, it is not without its problems. OTEC plants have efficiencies ranging from 1 to 3%. This creates high capital costs with little initial return. This is probably the main reason why private enterprise has not worked independently on OTEC. Because of this OTEC's future lies within the government's hand and

its ability to provide the necessary R and D dollars. Funding is necessary to conduct research in reducing biofouling and corrosion. These problems must be mastered before OTEC can become a commercial reality. Generally, specialist in the field believe that on a commercial basis, OTEC will not come until close to the end of this century, at the earliest. When constructed, a large plant would likely require at least the following type of workers: construction, mechanics, utilities personnel, pipefitters, refrigeration workers, and operations/maintenance personnel.

Discussion

Since further research and financing are required, the job market impact of OTEC is difficult to discern. Commercial viability appears to be many years away and the skill and knowledge as well as manpower demands are uncertain. But on the surface, it seems that people with existing occupational skills and knowledge will be able to do what the system require.

Direct Solar Energy

Direct solar energy is already being used quite extensively in Hawaii for industrial as well as domestic water heating. Over 5,000 solar water heaters had been installed on Oahu by 1979.

Most of these water heaters are flat plate collectors where water is filtered through two black plates and heated by the sun. The pay back period for these collectors ranges from five to nine years for residential systems and from three to five years for commercial systems. A high initial cost coupled with this slow pay back period

has discouraged many from investing in solar heaters. However, as the price for oil continues to rise, it is expected that more individuals as well as commercial firms will invest in solar water heating. Industry is of the belief that solar water heater sales will continue to rise over the next four years after which there might be a slight decline due to market saturation.

Many of the solar water heating companies are also distributing and installing heat pumps. A heat pump is a device that utilizes the heat created by the already existing air conditioning unit to heat water. Industry leaders feel that heat pumps have a more promising future than the conventional solar devices. However, slightly more education and job skills are required to work with heat pumps. The workers must understand concepts such as heat transfer and instrumentation. This is in contract to the current workers in the solar water heater industry who apply skills and knowledge that are common to other occupational areas such as welding, system design, electricity, pipefitting, plumbing, sheetmetal, and carpentry.

Direct solar energy also has other applications. It can be used to create electricity through one of two processes--thermoelectric conversion or photovoltaic conversion.

There are two thermoelectric conversion processes being considered in Hawaii. One uses curved surface concentrators which directs the sun's heat to a receiver unit near the center of the plate. This concentrated heat causes a working fluid such as helium

to expand and drive a generator. The other concept is using mirrors to direct the sun's light to a receiving tower. This heat is used to turn water into steam. Both of these concepts are being considered for specific application in Hawaii but they are still in the research stages and have a long way to go before they can be commercially used.

Photovoltaic conversion cells are on the verge of commercialization and are expected to be competitive for home use within the next four years. The cost to manufacture these cells has dropped significantly over the past few years. As the price for these cells gets into the competitive range, sales for residential and commercial applications will increase. Job creation will probably follow a path similar to that of solar water heater installation and service. Industry personnel feels that a basic photovoltaic concepts course would be helpful for the future worker in the field. However, because of the complexity of the system, there is also the possibility that a full curriculum may be necessary on photovoltaic installation and servicing.

Discussion

Currently solar water heating is the only alternative energy source that has been developed for commercial application on a scale that would require a skilled work force of significance. But the skill and knowledge requirements are those that can be transferred from existing trades such as electricity, carpentry, welding, etc. Moreover entry level workers without skills have been able to learn on the job in a relatively short time. Therefore, a specialized training program dealing with solar water heating would not be justified.

The photovoltaic system may require a specially trained work force to install and service the system. As such, educators should keep up with the development of this system and be ready to conduct a task analysis survey at the appropriate time.

Wind Energy Conversion Systems (WECS)

Hawaii, with its strong tradewinds and geographic relief, has a large wind energy potential. Small Wind Energy Conversion System (SWECS) could be used in small businesses, farms, or even households. While it is true that WECS can now be employed for commercialization there are still many problems that need to be worked out. The high cost of purchasing and installing of a windmill is a big factor in the further usage of windpower. Land zoning regulations stipulating windmills can only be put up on agriculturally zone land inhibits windmill application. The maintenance cost is also a factor in WECS' viability. In addition, in Hawaii, the high moisture and salt content in the air make the wind turbines highly susceptible to corrosion. To prevent this, more periodic maintenance would be necessary, e.g., painting, lubricating, replacing worn parts, etc.

In terms of commercialization, Windfarms, Ltd. has undertaken a "first-of-a-kind" project. Windfarms plans to develop an 80 megawatt "windfarm" along three ridges above Kahuku on Oahu's North Shore by installing 20 wind turbines, each capable of producing 4 megawatt. The first machines should arrive in about a year and a half, after the construction of the roads to the proposed sites.

The installation of the windmills will be in phases. The first phase will consist of the installation of six units along one ridge.

Engineers will then pause in the installation operation to allow time for an evaluation of "Murphy's Law" and to correct any problems that may crop up. In the second phase, additional units will then be added. The last machine should be in place in 1985.

In terms of operation and maintenance, the wind turbines will require very little attention. Most of the turbine's operation will be controlled by microprocessors. Approximately 20-25 regular jobs would be created with the development of the "windfarm." Windfarms will probably contract Hawaiian Electric Company to fill most of the jobs. This is because HECO has the manpower familiar with generation and transmission of electricity and it also has its own training program. In addition, Hamilton Standard, the manufacture of the wind turbine will assist Windfarms in trouble shooting. Workers on the windfarm will probably need skills for the following types of jobs: hydraulic--mechanics, automotive mechanics, equipment operators; electrician--transmission, electrical system; field maintenance--road and groundskeepers; corrosion control--maintenance and machine parts; and, security.

Windfarms also plans to create a smaller windfarm in the North Kohala area on the Island of Hawaii. This farm will have between 5-8 machines. The first machine is projected to be functional by 1983. Employment would be similar to the Kahuku farm, i.e., approximately 10-15 jobs will be created.

Spinoff companies such as Air Electric Hawaii tentatively plans to start manufacturing windmills. According to Bill Wilson, president of Air Electric, they plan to tentatively hire 10 production personnel

and five office workers. The production personnel would be trained machinists, electricians, and mechanics who will produce generators for the windmills. Air Electric hopes, later, to expand the operation to about 50 workers.

Discussion

Wind energy conversion system has been operational and commercially applied. There will be need for workers to maintain and service the system. However, workers with existing skills and pre-service workers going through existing training programs, such as HBCC's and the community colleges' will be adequate to meet the demand for workers in WECS.

Summary, Conclusions and Recommendations

Summary

Because of the rising costs and finiteness of fossil fuel, alternative energy sources must be explored and developed. Alternative sources that have been identified and could be applicable to Hawaii are: Biomass Conversion; Geothermal; Ocean Thermal Energy Conversion; Direct Solar; and Wind. Each of these alternative energy sources has been researched and developed to various stages of commercial applicability. Continued research and development should make more of the alternative energy sources commercially viable.

While the alternative sources have been developed into various levels of usefulness in residential and industrial applications, the technologies are such that new job categories have not emerged with

the advances nor the need for substantially additional workers. Rather, existing technical skills and knowledge have been readily adapted. That is to say, jobs that require new applications of existing skills have not kept the worker from learning while working and becoming productive in a relatively short time. And employees have changed their careers, thus negating any need for additional workers. However, new technological breakthroughs in the developing of newer energy sources may require new skills and knowledge that are currently non-existent and may call for new workers.

The study was focused and conducted 1) to estimate the number of workers needed to maintain the various alternative energy systems, 2) to estimate the manpower need for five years in the future, and 3) to determine the skills and knowledge required of workers. These objectives were variously realized by interviewing people working in the alternative energy source field and researchers and experts engaged in further development of these alternative energy sources. The data and information obtained were analyzed and herein reported.

The two largest applications of alternative energy sources in Hawaii have been in solar water heating and the burning of bagasse and wood chips, first to generate heat, next to convert liquid to steam, then to drive turbines and, lastly, to produce electricity. Geothermal energy and wind energy are initially being applied to produce electricity. The potential for further development of these two sources is promising and should expand in the next few years.

OTEC is still in the research and development stage and may be a decade away before it is commercially applied. But to reiterate the absence of any real impact to new skills and knowledge and to new workers, essentially the existing work force and the existing educational programs appear to satisfy the technical and manpower needs adequately.

Conclusion

Through the analysis of the data and information, certain general findings and trends emerged. The use of alternative energy sources will become more pervasive and will create jobs. But the number of jobs will be limited because of the utilization of automated systems and mechanization. Secondary industries, such as the tree farms and plant related industries, may require more workers, but they may be at the non-skilled or semi-skilled levels. Moreover, the general technical skills and knowledge learned through existing educational programs and job situations may suffice as far as pre-service and in-service training needs are concerned. These observations emanated from the conclusions as detailed below, of the developmental aspects of the alternative sources of energy.

1. Biomass conversion has been in use by the sugar plantations for a number of years. Bagasse, the waste fiber of the sugar cane after it has been crushed, has been burned to generate steam to produce electrical energy. Wood chips from tree

farms are also burned to supplement the bagasse. While the technology has been commercially applied, it has not created any significant number of new jobs. The jobs that have resulted do not require special skill training that existing educational programs can already provide. Unless new plants are constructed employees will be reassigned from their existing jobs.

2. Geothermal energy system has been applied with the construction of the Hawaii Geothermal Projects' A-well. Additional wells are planned for the next few years. The personnel required to maintain and service the wells range from plant managers and engineers to maintenance workers. Similar to bioconversion, however, this mode of alternative energy source requires skills and knowledge that individuals already possess through formal training and/or work experience.
3. Ocean Thermal Energy Conversion system is still in the developmental stages and will be sometime in the future before commercially applied. Advancement of this technology will be closely tied to the availability of federal funds. Private interests, generally, are not ready to commit their resources until OTEC can be shown to be commercially viable. Current manpower requirements center on individuals with research and engineering skills. Existing professional and technical education programs suffice to meet the manpower demands for the foreseeable future.

4. Solar water heating using direct solar energy has been applied quite extensively in commercial and residential buildings. While the process is not new, the advancement of technologies in constructing and installing the solar water heating unit has made the commercial application economical and practical. However, the skills and knowledge required for installation of the unit require performance of tasks that are common to plumbing, welding, electrician and carpentry. Work in this area requires that the individual is able to transfer previously learned skills to a new application.

   However, the use of solar energy in the photovoltaic system may demand workers with new skills and knowledge. The technology is on the brink of becoming commercially viable. The main obstacle has been the cost. With the cost of production decreasing and the price of oil increasing, the breakthrough should be coming soon. Accordingly, there exists a distinct possibility for the need to develop and implement short training programs in the installation, maintenance, and servicing of photovoltaic energy systems. Deliverers of training programs should scrutinize the development in this alternative energy producing system.

5. Wind energy to perform work is not new, but wind energy conversion into another form of energy that is economically viable is new. The application of WECS will be seen in the State with the installation of wind driven turbines on the North Shore of Oahu. Since the wind driven electrical

generators are seen as electrical power plants, the work force to maintain and service WECS will likely come from Hawaiian Electric Company. It has the training program as well as the in-service workers who will be able to man the wind farm. Graduates coming from public training programs will be able to supplement the manpower requirements.

While further advances in the commercial use of alternative energy sources will depend to a great deal on economic factors, such as the increase in oil prices and the cost of the technology, current state-of-the-art in technology does not justify a full blown energy technician training program. The graduate of existing professional and technical curricula suffice to meet the manpower needs.

Recommendations

In light of the analysis of the data and information and the foregoing conclusions, it appears that the following recommendations are appropriate:

1. Unless there is evidence to the contrary for the next two or three years, the community colleges should not initiate energy technician training programs. However, another inquiry should be conducted in three or four years to determine if there is a need for a energy technician program, especially dealing with photovoltaic system.
2. Course(s) dealing with installation, maintenance, and servicing of alternative energy sources should be added to appropriate existing technical programs.
3. Course(s) in the use and conservation of energy should be added to the curriculum if it is not now included.

Part III

Energy Awareness for Campus/Community

The third committee of the Energy Task Force found its work hampered by overlapping on objectives similar to those of the other groups. They recognized the interrelated nature of conservation practices and teaching energy values. Their concerns about campus awareness and conservation were eventually taken up by the first committee. An additional complex problem of definition is whether to distinguish between vocational energy education and general education about energy.

A survey of each campus indicated that much energy-related material is being taught in classes ranging from sections in courses to semester length courses. These involve such diverse disciplines as automotive technology, business, sociology, chemistry, physics, geography and political sciences. These courses, in general, raise the awareness level of the student to the technical, social and political problems related to the production and use of energy. While the general education courses do not provide technical skills, they do provide insight into the problems from an individual and global perspective.

Recommendations

The recommendations in this area include:

1. The development of an energy-related curricula be an ongoing project and that curriculum modification and development be supported by appropriate EIF and DOE grants.

2. Courses successfully developed and taught on one campus should be considered models for systemwide use.
3. A materials network focused on energy curriculum should be established and be managed by campus libraries, including exchanges of material between campuses.
4. In the area of community services, there is very limited involvement by any campus. A leadership role could be taken by community colleges in this area, including giving workshops in energy awareness off campus for community organizations, and the use of campuses as resource centers for providing technical assistance to homeowners on energy audits, conservation practices, and retrofitting existing energy systems.

REFERENCES

Albright, B.A., Report to the American Vocational Association. Energy Awareness Advisory Committee Meeting, March 1980, Arlington, VA.

Alternate Energy Sources for Hawaii, Committee on Alternate Energy Sources Hawaii of the State Advisory Task Force on Energy Policy, February, 1975.

An Agri-Energy (Biomass) Co-Generation Program for the State of Hawaii, Board of Agriculture, State of Hawaii, September 1, 1977.

Appropriate Energy Technology in Hawaii, Department of Planning and Economic Development, October, 1979.

"Bagasse Perks Up Kauai's Power," Honolulu Advertiser, November 25, 1981.

BioEnergy Development Corporation
Pamphlet put out by the BioEnergy Development Corporation.

C. Brewer & Company, Ltd.
Main Office, 827 Fort Street, Jerry Allen, 536-4461.

Cheremisinoff, P.N., & Morresi, A.C., Geothermal Energy Technology Assessment. Westport, Conn.,: Technomic, 1976.

Cheremisinoff, P.N., & Regino, T.C., Principles and Applications of Solar Energy. Ann Arbor, Michigan; Ann Arbor Science, 1978.

City and County of Oahu, Refuse Division, Kapiolani & King, 14th Floor, Municipal Building, Fred Chan, and Tom Vendetta, 523-4774.

Congressional Committee on Interstate and Foreign Commerce, U.S. House of Representatives. Energy: An Uncertain Future. An Analysis of U.S. and World Energy Projects Through 1990. Washington, D.C.: U.S. Government Printing Office, December, 1978.

"Davies Dedicating Generator," Honolulu Star-Bulletin, August 4, 1981.

Del Monte Corporation, 500 Sumner, Ken Kawakami, 537-5321.

Department of Energy (DOE). Solar Energy Program Summary Document FY 1981 (DOE-CS-0050). Assistant Secretary for Conservation and Solar Energy, August, 1980.

Dillingham Corporation, Ala Moana Building, 1441 Kapiolani Boulevard, Ralph Paterson, 944-4414.

Division of Forestry, Robert Miriam, 548-2861.

Doggette, J.R. and Stevenson, W., "Energy-Realted Employment and Vocational Education During the 1980's." In Curriclum Development Needs for Vocational Education: New and Changing Occupations, edited by M.N. Orth and J. Russell. Ohio State, University National Center for Research in Vocational Education, January , 1980.

Doggette, J.R., Energy-Related Technology Programs in Community and Junior Colleges: An Analysis of Existing and Planned Programs. Oak Ridge, TW: Oak Ridge Associated Universities, July, 1976.

Dole Company, 650 Iwilei Road, Bob Trout, 536-3411.

DPED-OTEC, Kent Keith, 548-8419.

Edington, E.D., Keaton, L., and Neberay, Y., Policies and Manpower Needs Related to Emerging Energy Sources in Arizona and New Mexico. Las Cruces, New Mexico: New Mexico State University, 1977 (ERIC Document Reproduction Service No. 166 550).

Electrical Energy from Ocean Waves, Ronald Ken Watanabe, August, 1977.

Ecological Engineering, 745 Fort St., Suite 300, Gene Furr, 543-3421.

Energy in the Pacific, Energy Research and Development Administration Public Meeting, Honolulu, Hawaii, June 30, 1977.

Ensign, M.D. and Richins, M.P., So You Want to Train Solar Technicians. Community and Junior College Journal, November, 1978, pp. 34-36.

Ertel, Kenneth, Energy: Factors Influencing Vocational Education Policy. Ohio State University, National Center for Research in Vocational Education, January 1981.

Palicoff, W., Koide, G., Takahashi, P., Solar/Wind Handbook for Hawaii. Honolulu: Hawaii Natural Energy Institute, 1979.

[Feasibility of Developing Post High School Technician Programs for Emerging Energy Sources in South-Western United States.] Policies and Manpower Need Related to Emerging Energy Sources in Arizona and New Mexico, Final Report, by Edington, Everett, and Others. New Mexico State University, Las Cruces, Bureau of Educational Research, August 15, 1977.

Forgionne, P.D., Jr. and Koss, L., "Curriculum Development Need for Vocational Education: New and Changing Occupations." Ohio State University, NCR in VE, 1979.

Geothermal Power Economics: An Annotated Bibliography, N. El-Ranly, R. Peterson, K.K. Seo, Hawaii Geothermal Project, University of Hawaii February, 1974.

Geothermal Power Economics: An Annotated Bibliography Volume II, R.E. Peterson and K.K. Seo, Hawaii Geothermal Project, University of Hawaii, September, 1974.

Hawaii and Energy, Vickie Kim, State of Hawaii, Department of Planning and Economic Development, 1975.

HNEI 1980 Annual Report, Hawaii Natural Energy Institute, University of Hawaii at Manoa, 2540 Dole Street, Honolulu, Hawaii 96822.

Hawaii's Sugar Islands. Hawaiian Sugar Planters' Association, P.O. Box 1057 Aiea, Hawaii 96701.

Hawaiian Electric Company 1980 Annual Report, Hawaiian Electric Company, P.O. Box 2750, Honolulu, Hawaii 96840.

"HPOWER - June to Volts," Honolulu Advertiser, March 22, 1981.

Jobs from Renewable Energy Development Programs.
(An unpublished document shown by Dr. Richard Neil.)

National Oceanic and Atmospheric Administration (NOAA). Ocean Thermal Energy Conversion (Draft Environmental Impact Statement). Washington, D.C.: U.S. Government Printing Office, March, 1981.

"Oahu's Windfarm: A Giant Engineering Challenge," Building Industry Digest of Hawaii, June, 1981.

OTEC for Oahu, Ad Hoc Committee on the Advancement of OTEC for Hawaii, February, 1980.

Pacific Resources, Inc., Main office, 733 Bishop St., 547-3111, Corporate Development, Edward Lui, 547-3237.

Proceedings of the Hawaii Conference on Jobs and the Environment, sponsored by the Life of the Land, 1978.

"Pyrolysis for Solid Waste Management," Judieth D. Liebeskind, September, 1973.

Rodberg, L.S., Employment Impact of the Solar Transition (Joint Economic Committee, Congress of the United States). Washington, D.C.: U.S. Government Printing Office, 1979.

State Energy Plan and Technical Reference Document, Department of Planning and Economic Development, September, 1980.

State Energy Resources Coordinator: 1979 Annual Report, Department of Planning and Economic Development, January, 1980.

Tester, J.W., and Milora, S.L., Geothermal Energy for Electrical and Non-electrical Applications. In D.N. Cox (Chair), 16th Annual ASME Symposium on Energy Alternatives. Albuquerque, New Mexico: New Mexico section American Society of Mechanical Engineers, 1976.

Troy, M., HNEI 1980 Annual Report. Honolulu, Hawaii: Hawaii Natural Energy Institute, 1980.

Twenty Percent Solar in 20 Years -An Attainable Goal: Thomas Stelson, Energy Insider, March 17, 1980, p. 5.

Velocci, T., How Bright Is Sunpower's Future? Nation's Business, 1980 68 (11), 46.

Windfarms, Inc., 130 Merchant St., Suite 1104, George Stricker, 526-0411.

Yen, W., W.S., & Iacofano, D.S., Geothermal Energy for Hawaii A Prospectus. Honolulu, Hawaii: State of Hawaii Department of Planning and Economic Development, July, 1981.

ERIC Clearinghouse for Junior Colleges
96 Powell Library Building
University of California
Los Angeles, California 90024

APR 30 1982